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The Effects of Shocks on the Ukrainian Labor Market: SVEC Modeling

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Abstract

The article analyzes dynamics of the Ukrainian labor market during 2002-2014 years. In the result of conducted econometric analysis we created structural vector autoregressive error correction model for labor productivity, employment, unemployment rate and real wages. The analysis of impulse response to technological shocks, labor demand shocks, labor supply shocks and wage-setting shocks was conducted on the basis of developed SVEC. The modeling results demonstrated that in Ukraine there is no single reason for hysteresis in unemployment. Various structural and cyclical shocks explain unemployment over different time horizons. In particular, labor supply shocks lead to contemporaneous growth of unemployment, while in the long run positive technological shocks and labor demand shocks are an important source of reducing unemployment rate. Technological shocks also have a significant beneficial impact on other labor market indicators. In particular was found that a positive technological shock causes an increase in productivity, employment and real wages, and this impact has a significant effect both in the short and in the long run.

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1. Introduction

The current state of Ukrainian labor market is characterized by instability and disparities which are inherent for transitional and crisis periods of economic development. Sphere of social and labor relations has various forms of

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asymmetry, inconsistencies in the structure of employment, wages and labor productivity, uneven distribution of income, social vulnerability of poor people, high unemployment and asymmetric processes of adaptation to changing market conditions.

Enlargement of informal employment, its close connections with formal sector and shadow employment rate in Ukraine lead to in a large number of processes in the labor market that are uncontrollable and irregular (Huk, 2014). Scientists reveal imbalance between labor force education and labor market needs existing in Ukraine thus indicating that these differences lead to inconsistencies and discrepancies between the level of workers qualification and workplaces they occupy, deterioration of quantitative and qualitative structure of the labor market (Kasmin, 2014, Serban, 2012). Ukrainian scientists (Kolot 2010, Glushach and Arkhiyeryev, 2013 among others) also study the impact of both integration processes taking place in the sphere of the financial sector and globalization on the real economy and employment, and also determine the positive and negative aspects of their influence. Samosyonok (2012) analyzes directions and intensity of the impact of regional economic integration processes on employment and income of population, determines the dependence of integration effects in the employment sphere on the level of country economic development and its sectoral specialization. Yuryk and Konovalov (2014) analyze flexibility of Ukrainian labor market and indicate that adaptation of domestic labor market to economic fluctuations doesn't happen due to changes in the number of employees, but by means of wages flexibility and back pay. The researchers also indicate that the causes of transformations in labor market development are innovative shifts that cause changes in the structure and scope of employment, labor productivity (Petrova, 2013, Vorontsova, 2014).

In terms of changing internal and external economic environment, globalization, structural transformations and macroeconomic disturbances it is very important to investigate the structural and cyclical factors of unemployment and characterize shocks which lead to permanent changes in the Ukrainian unemployment rate. The aim of our study is an empirical analysis and econometric modeling of the dynamic relation between labor productivity, number of employees, unemployment rate and real wages in Ukraine on the basis of structural vector error correction model. The conducted analysis will allow to characterize impact of technological shocks, labor demand shocks, labor supply shocks, wage shocks and to determine which of them have a long-term effect on the domestic labor market, and which have only a temporary impact.

A number of scientists conducted researches of influence of different disturbances on the labor markets of different countries and their analysis was based on structural vector models of the labor market. Jacobson, Vredin and Warne (1997) for the first time investigated the sources of fluctuations on the labor market in the Scandinavian countries on the basis of structural VAR model with common trends and identified factors of hysteresis in unemployment and differences between labor markets of Denmark, Norway and Sweden. In the result of modeling was detected the presence of hysteresis in unemployment not only on the labor market of Denmark, which demonstrates European trends, but also for Sweden and Norway, which are characterized by traditionally low and stable unemployment rate. The authors substantiate the existence of three disturbances which have a permanent impact on unemployment, namely these are technological shocks, labor supply shocks and shocks of equilibrium unemployment (or wage shocks). The impact of labor demand shocks has only a short-term impact. Saltari and Travaglini (2009) on the basis of analysis of three-dimensional structural VAR model for labor productivity, employment and aggregate demand claim that for explanation European economy dynamics in recent decades it has been necessary to take into account both technological shocks and non-technological shocks of labor supply, caused by institutional changes. The authors indicate that technological shocks are the cause of structural slowdown in productivity growth, but they can not explain the increase in employment. On the other hand, non-technological shocks cause dynamic changes in employment, but can not explain the slowdown in productivity. Carstensen and Hansen (2000) analyzed West German labor market by using a cointegrated structural VAR model in which cointegration long-term relations are interpreted as labor force demand, wage setting relation and equation of goods and services market equilibrium. Scientists detect the existence of two shocks which have permanent effects and three shocks which have temporary effects, as well as quantitatively characterize their dynamic impact. It is shown that the commodity market shocks or government shocks are important factors of unemployment in the short run. In the long term the unemployment rate in Germany is determined by technological shocks and labor supply shocks. In particular, a positive technological shock leads to a decrease in unemployment, but adjustment to new equilibrium level is quite sluggish. Maidorn (2003) investigates the hysteresis on the Austrian labor market, using SVAR model of the impact of four structural shocks such as shocks of productivity, demand, wages and labor supply. Partridge and Rickman (2009) analyze dynamics of Canadian

provincial labor markets on the basis of structural vector autoregression with long-run restrictions. Researches investigate three components of market fluctuations connected with labor demand shocks (new jobs), labor supply shocks which arise as a result of migration (new people) and internal labor supply (original residents). Park (2012) investigates influence of two types of technological shocks (aggregate and sectoral) to sectoral employment in the US manufacturing. For identifying each shock separately was constructed two VAR models: factor-augmented vector autoregression (FAVAR) for identifying the aggregate shocks and sectoral SVAR model for identifying sectoral shocks. Cravo (2011) study influence of economic activity fluctuations to employment on small and large businesses in different Brazilian sectors and regions, and show that behavior of the difference in employment growth rates between large and small firms is counter-cyclical.

Scientists claim that study of influence of different shocks on the labor market is particularly relevant and important for understanding labor market dynamics in order to devise national, sectoral and regional labor policies which are aimed at dampening employment fluctuations especially during periods of economic recession.

2. Theoretical model

As theoretical basis for empirical modeling we will use a modification of macroeconomical labor market model which was proposed by Jacobson, Vredin and Warne (1997). Theoretical model include modeling of production function, labor demand equation, labor supply equation and wage setting relation. We will denote natural logarithms of variables by small letters as it is usual for empirical analysis. Let $rgdp = \log RGDP$, $empl = \log EMPL$, $lf = \log$

LF , $wage = \log WAGE$ i $p = \log PRICE$ denote natural logarithms of real gross domestic product, number of employed in economics, labor force, average wage and price level respectively.

Production function will be defined as relation between an output and employment

$$rgdp_t = \rho empl_t + \theta_t, \quad (1)$$

where ρ measures returns to scale. Variable θ_t determines stochastic technology trend that follows a random walk

$$\theta_t = \theta_{t-1} + \varepsilon_t^{technology}, \quad (2)$$

where $\varepsilon_t^{technology}$ – is the pure technology shock.

Labor demand equation describes dependence of employment on real wages $rwage_t = wage_t - p_t = \log (WAGE_t / PRICE_t)$ and output

$$empl_t = -\eta rwage_t + \lambda rgdp_t + \zeta_t, \quad (3)$$

where parameters η and λ measure elasticities of employment by real wage and output accordingly. The variable ζ_t determines random disturbances of labor demand which are described by autoregressive process

$$\zeta_t = \varphi \zeta_{t-1} + \varepsilon_t^{demand}. \quad (4)$$

If $|\varphi| < 1$, than labor demand trend is stationary and innovations of labor demand ε_t^{demand} have only temporary effects on employment. In particular, in a partial case $\varphi = 0$ (Jacobson et al., 1997), labor demand shocks do not have a long-term impact on employment.

The third component of the model characterizes labor supply equation and describes the relationship between labor force and real wages

$$lf_t = \pi rwage_t + \xi_t. \quad (5)$$

Exogenous labor supply trend ζ_t is described by a random walk process

$$\zeta_t = \zeta_{t-1} + \varepsilon_t^{supply}, \quad (6)$$

where the parameter π measures the slope of the labor supply curve that is the elasticity of labor supply and ε_t^{supply} is a labor supply shock. In the particular case where π is equal to zero, we obtain exogenous labor force.

The wage-setting relation takes the form

$$rwage_t = \delta (rgdp_t - empl_t) + \kappa empl_t - \gamma (lf_t - empl_t) + \varsigma_t \quad (7)$$

and shows that real wages depend on labor productivity $prod_t = rgdp_t - empl_t$, employment $empl_t$ and unemployment rate, which is defined as $UR_t = lf_t - empl_t$. Wages trend ς_t can be stationary or nonstationary, depending on the parameter ψ of autoregressive process

$$\varsigma_t = \psi \varsigma_{t-1} + \varepsilon_t^{rwage}, \quad (8)$$

which characterizes its behavior. If $|\psi| < 1$, then the wage trend is stationary, otherwise the process of wage formation is described by a stochastic trend characterizing the accumulation of permanent random shocks with zero mean and constant variation.

Assume that all four pure shocks, namely technological shocks $\varepsilon_t^{technology}$, labor demand shocks ε_t^{demand} , labor supply shocks ε_t^{supply} and wages shocks ε_t^{rwage} are iid. Gaussian with zero mean, variances $\sigma_i^2 > 0$ for $i = technology, demand, supply, rwage$ and zero covariances.

Transform the model (1) – (8) to the model regarding variables which are used in the empirical analysis of the labor market, namely, productivity $rgdp_t - empl_t$, employment $empl_t$, the unemployment rate $lf_t - empl_t$ and real wages $rwage_t$ and it is written in vector form

$$\begin{pmatrix} 1 & 1-\rho & 0 & 0 \\ -\lambda & 1-\lambda & 0 & \eta \\ 0 & 1 & 1 & -\pi \\ -\delta & \kappa & \gamma & 1 \end{pmatrix} \begin{pmatrix} rgdp_t - empl_t \\ empl_t \\ lf_t - empl_t \\ rwage_t \end{pmatrix} = \begin{pmatrix} \theta_t \\ \zeta_t \\ \xi_t \\ \varsigma_t \end{pmatrix} \quad (9)$$

or more compactly

$$A y_t = \omega_t,$$

where $y_t = (rgdp_t - empl_t, empl_t, lf_t - empl_t, rwage_t)'$ – vector of endogenous variables, $\omega_t = (\theta_t, \zeta_t, \xi_t, \varsigma_t)'$ – vector of disturbances.

Model (9) describes the dynamic behavior of labor market indicators such as productivity, employment, unemployment rate and real wages, which are driven by four unobserved components: the two random walks in labor supply ζ_t and technology θ_t , and two stochastic components ξ_t and ς_t which arise due to shocks to the wage setting relation and labor demand equation. Each of these components can be stationary if $|\varphi| < 1$ or $|\psi| < 1$ respectively, or nonstationary if the $|\varphi| = 1$ or $|\psi| = 1$.

3. Empirical methodology and data analysis

For empirical analysis and modeling of Ukrainian labor market we will use quarterly data of the State Statistics Service of Ukraine for the period from the first quarter of 2002 to the second quarter of 2014. Labor productivity

series will be defined by subtracting the logarithm of the number of employees $EMPL$ from logarithm of real gross domestic product $RGDP$, that is $prod_t = \log PROD_t = \log (RGDP_t/EMPL_t) = \log RGDP_t - \log EMPL_t = rgdp_t - empl_t$. UR_t variable denotes the unemployment rate, which is defined by the International Labor Organization and $rwage_t = \log RWAGE_t = \log (WAGE_t/PRICE_t) = \log WAGE_t - \log PRICE_t = wage_t - p_t$ denotes series of logarithms of real wages. For modeling we use series which previously were adjusted for seasonality (using method CensusX12) and determined shifts in average values at different time intervals.

Therefore we conduct modeling of time series vector

$$y_t = (prod_t \quad empl_t \quad UR_t \quad rwage_t)'$$

on basis of structural vector autoregressive model

$$y_t = A_1^* y_{t-1} + \dots + A_p^* y_{t-p} + B \varepsilon_t.$$

Selecting the lag length of a VAR specification is done on the basis of the Akaike information criterion (AIC), the Hannan-Quinn criterion (HQ) and the Schwarz criterion (SC), and also results of autocorrelation, nonnormality, and heteroskedasticity effects in the VAR residuals for various lags orders. Taking into account that when $p = 4$, none of the diagnostic tests indicate signs of misspecification, we continue analysis using VAR (4) model.

Fig. 1–2 shows the behavior of time series of labor productivity number of employees, unemployment rate and real wages, and the dynamics of seasonally adjusted data.

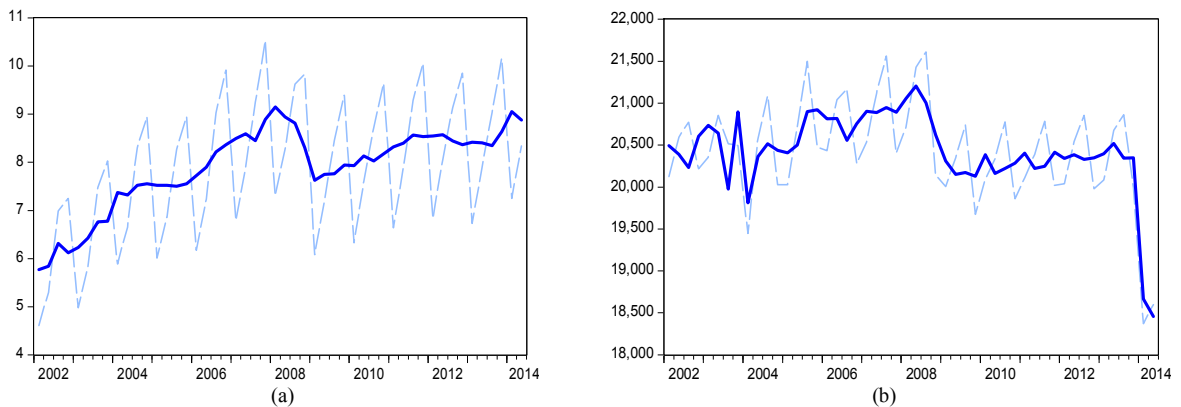


Fig. 1. Dynamics of (a) the time series of labor productivity ($PROD_t$) and its seasonally adjusted data;
(b) the time series of employees number ($EMPL_t$) and its seasonally adjusted data.

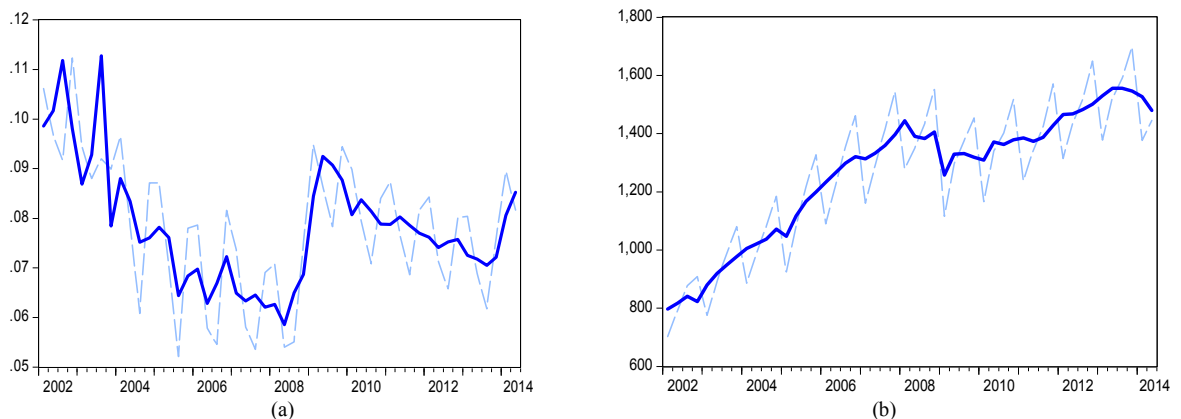


Fig. 2. Dynamics of (a) the time series of unemployment rate (UR_t) and its seasonally adjusted data;
(b) the time series of real wages ($RWAGE_t$) and its seasonally adjusted data.

Source: data of the State Statistics Service of Ukraine, evaluations of the authors.

Time series of labor productivity and real wages show an upward trending behavior and although this trend is not observed in the series of employees number and unemployment rate, but none of the four time series looks like stationary. So before estimation of reduced-form of VAR model we will conduct testing of nonstationary nature of studied series using augmented Dickey-Fuller unit root test. Results of a unit root tests are presented in Table 1. Considering the form of time series shown in Fig. 1–2 a constant and a deterministic time trend are included in the test regressions, besides additionally was researched specifications only with constant when testing of unit root for employment and unemployment rate series. Selection of the number of lagged differences which is included in ADF-test is conducted on the basis SIC criterion.

Table 1. Augmented Dickey–Fuller unit root test results

Variable	Deterministic terms	Lags	Max. Lag	Critical values			Test statistic	p-value
				10%	5%	1%		
<i>prod</i>	const, trend	1	8	-3.183	-3.506	-4.161	-2.3621	0.3940
$\Delta prod$	const	0	7	-2.599	-2.922	-3.571	-5.3369	0.0000
<i>empl</i>	const, trend	0	8	-3.183	-3.506	-4.161	-4.8062	0.0016
	const	1	4	-2.599	-2.922	-3.571	-2.6672	0.0872
	const, trend	1	4	-3.183	-3.506	-4.161	-2.6548	0.2593
$\Delta empl$	const	0	7	-2.599	-2.922	-3.571	-12.912	0.0000
<i>UR</i>	const, trend	0	8	-3.183	-3.506	-4.161	-2.6015	0.2815
	const	0	8	-2.599	-2.922	-3.571	-2.7112	0.0794
ΔUR	—	0	7	-1.612	-1.947	-2.614	-8.9960	0.0000
<i>rwage</i>	const, trend	1	8	-3.183	-3.506	-4.161	-1.9884	0.5926
$\Delta rwage$	const	0	7	-2.599	-2.922	-3.571	-4.7972	0.0003

Source: data of the State Statistics Service of Ukraine, evaluations of the authors.

Results of the conducted tests confirm the presence of a unit root in levels of all series, while the first differences are stationary. Therefore, series $prod_t$, $empl_t$, UR_t and $rwage_t$ are integrated of the first order and can be treated as $I(1)$ variables.

Should be noted, that integration of unemployment series means that unemployment has a permanent component, which is described by the process of random walk, and serially correlated transitory component. These components, in particular, can be interpreted as structural and cyclical unemployment, but that the two will in general be correlated.

Structural vector autoregressive model makes it possible to analyze the impact of structural shocks, based on the research of stochastic trends and allows to differentiating and isolating the impact of shocks with permanent effect and shocks with temporary effect. The theoretical model (1) – (8), which is a basis for empirical research, provides the possibility of existence of one or two temporary shocks that are related to labor demand shocks and wages shocks, and accordingly at least two and no more than four common trends. Research of common stochastic trends presence is based on cointegration analysis of variables. In particular, if there is one cointegration relation ($r=1$) between variables of four dimensional VAR model of the labor market ($n=4$), then dynamics of productivity, employment, unemployment rate and real wages are defined by $k=n-r=3$ shocks that have a permanent effect, and if was substantiated the existence of two cointegration relations, we get only two common trends.

Taking into account detected the same order of integration and trend properties of time series $prod_t$, $empl_t$, UR_t and $rwage_t$, we explore the existence of possible cointegration relationships between them. To check the cointegration we use the VAR(4) specification and investigate the cointegration relationship with various deterministic terms.

According to the Johansen methodology testing of cointegrating rank we perform using a likelihood ratio test, namely the maximum eigenvalue statistics and trace test. The results of these tests are shown in Table 2.

The results of conducted tests show that when testing the existence of cointegration relations that include determined shift and do not include the trend, the choice is not justified. In the case of inclusion of linear trend in the cointegration relation both statistics of maximum eigenvalue and trace statistics indicate the existence and correctness of one cointegration long-term equilibrium relationship usage in the estimation of error correction model.

Table 2. The results of testing the cointegration relationships between labor market indicators

Hypothesis	Eigenvalues	LR-statistics		95% critical values		p-values	
		λ -max	trace	λ -max	trace	λ -max	Trace
Cointegration relation doesn't include trend							
$H_0: r = 0$	0.6716	50.12*	86.11*	27.5843	47.8561	0.0000	0.0000
$H_0: r \leq 1$	0.3794	21.47*	35.99*	21.1316	29.7970	0.0448	0.0085
$H_0: r \leq 2$	0.2102	10.62	14.52	14.2646	15.4947	0.1742	0.0697
$H_0: r \leq 3$	0.0829	3.89*	3.89*	3.8414	3.8414	0.0483	0.0483
Cointegration relation includes linear trend							
$H_0: r = 0$	0.6952	53.47*	93.07*	32.1183	63.8761	0.0000	0.0000
$H_0: r \leq 1$	0.4043	23.31	39.59	25.8232	42.9152	0.1036	0.1033
$H_0: r \leq 2$	0.2405	12.38	16.28	19.3870	25.8721	0.3803	0.4701
$H_0: r \leq 3$	0.0829	3.89	3.89	12.5179	12.5179	0.7567	0.7567

Source: evaluation of the authors.

4. Results

Taking into account adequacy of lags order $p = 4$ for previous VAR model in levels, we include three lags of the differences of the variables in VEC specification. So build a VECM with one cointegration vector

$$\begin{pmatrix} prod_t \\ empl_t \\ UR_t \\ rwage_t \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{pmatrix} \left[(\beta_1 \ \beta_2 \ \beta_3 \ \beta_4) \begin{pmatrix} prod_{t-1} \\ empl_{t-1} \\ UR_{t-1} \\ rwage_{t-1} \end{pmatrix} + (\beta_5 \ \beta_6) \begin{pmatrix} Trend_{t-1} \\ Dshift2008Q4_{t-1} \end{pmatrix} \right] + \\
 + \begin{pmatrix} \gamma_{11}^1 & \gamma_{12}^1 & \gamma_{13}^1 & \gamma_{14}^1 \\ \gamma_{21}^1 & \gamma_{22}^1 & \gamma_{23}^1 & \gamma_{24}^1 \\ \gamma_{31}^1 & \gamma_{32}^1 & \gamma_{33}^1 & \gamma_{34}^1 \\ \gamma_{41}^1 & \gamma_{42}^1 & \gamma_{43}^1 & \gamma_{44}^1 \end{pmatrix} \begin{pmatrix} \Delta prod_{t-1} \\ \Delta empl_{t-1} \\ \Delta UR_{t-1} \\ \Delta rwage_{t-1} \end{pmatrix} + \begin{pmatrix} \gamma_{11}^2 & \gamma_{12}^2 & \gamma_{13}^2 & \gamma_{14}^2 \\ \gamma_{21}^2 & \gamma_{22}^2 & \gamma_{23}^2 & \gamma_{24}^2 \\ \gamma_{31}^2 & \gamma_{32}^2 & \gamma_{33}^2 & \gamma_{34}^2 \\ \gamma_{41}^2 & \gamma_{42}^2 & \gamma_{43}^2 & \gamma_{44}^2 \end{pmatrix} \begin{pmatrix} \Delta prod_{t-2} \\ \Delta empl_{t-2} \\ \Delta UR_{t-2} \\ \Delta rwage_{t-2} \end{pmatrix} + \\
 + \begin{pmatrix} \gamma_{11}^3 & \gamma_{12}^3 & \gamma_{13}^3 & \gamma_{14}^3 \\ \gamma_{21}^3 & \gamma_{22}^3 & \gamma_{23}^3 & \gamma_{24}^3 \\ \gamma_{31}^3 & \gamma_{32}^3 & \gamma_{33}^3 & \gamma_{34}^3 \\ \gamma_{41}^3 & \gamma_{42}^3 & \gamma_{43}^3 & \gamma_{44}^3 \end{pmatrix} \begin{pmatrix} \Delta prod_{t-3} \\ \Delta empl_{t-3} \\ \Delta UR_{t-3} \\ \Delta rwage_{t-3} \end{pmatrix} + \begin{pmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \\ c_{41} & c_{42} & c_{43} \end{pmatrix} \begin{pmatrix} Dimpulse2008Q4_t \\ Dimpulse2014Q1_t \\ Const \end{pmatrix} + \begin{pmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{pmatrix}. \quad (10)$$

Estimation results for parameters of VEC model (10) are shown in Table 3. Table 4 presents Johansen ML-estimation of cointegration vector β and vector of adjustment coefficients α to detected long-term cointegration relationship for each variable.

Table 3. Parameters estimation of vector autoregressive error correction model

Variables	Equation for $\Delta prod$			Equation for $\Delta empl$			Equation for ΔUR			Equation for $\Delta rwage$		
	Coefficient	t-stat.		Coefficient	t-stat.		Coefficient	t-stat.		Coefficient	t-stat.	
	(st.dev.)	[p-value]		(st.dev.)	(p-value)		(st.dev.)	(p-value)		(st.dev.)	(p-value)	
$\Delta prod(t-1)$	0.332	1.834		-0.044	-0.781		0.021	0.596		0.309	1.476	
	(0.181)	[0.067]		(0.056)	[0.435]		(0.035)	[0.551]		(0.209)	[0.140]	
$\Delta empl(t-1)$	-1.821	-3.176		0.491	2.773		-0.025	-0.232		-0.363	-0.547	
	(0.573)	[0.001]		(0.177)	[0.006]		(0.110)	[0.817]		(0.664)	[0.584]	
$\Delta UR(t-1)$	0.180	0.199		0.400	1.428		-0.333	-1.917		1.172	1.116	

$\Delta rwage(t-1)$	(0.907) 0.269	[0.842] 2.222	(0.280) 0.044	[0.153] 1.184	(0.174) -0.080	[0.055] -3.463	(1.050) 0.331	[0.264] 2.359
$\Delta prod(t-2)$	(0.121) -0.129	[0.026] -0.820	(0.037) -0.118	[0.236] -2.425	(0.023) -0.025	[0.001] -0.819	(0.140) -0.616	[0.018] -3.372
$\Delta empl(t-2)$	(0.158) -1.713	[0.412] -3.495	(0.049) 0.140	[0.015] 0.922	(0.030) -0.011	[0.413] -0.121	(0.183) -1.625	[0.001] -2.865
$\Delta UR(t-2)$	(0.490) 0.366	[0.000] 0.499	(0.151) -0.116	[0.357] -0.513	(0.094) -0.290	[0.903] -2.060	(0.567) -0.901	[0.004] -1.061
$\Delta rwage(t-2)$	(0.734) 0.117	[0.618] 1.028	(0.227) 0.041	[0.608] 1.167	(0.141) -0.004	[0.039] -0.199	(0.850) 0.118	[0.289] 0.896
$\Delta prod(t-3)$	(0.114) 0.438	[0.304] 2.153	(0.035) -0.119	[0.243] -1.891	(0.022) 0.033	[0.842] 0.853	(0.132) 0.760	[0.370] 3.225
$\Delta empl(t-3)$	(0.204) -0.188	[0.031] -0.478	(0.063) -0.103	[0.059] -0.854	(0.039) 0.095	[0.394] 1.257	(0.236) 0.141	[0.001] 0.310
$\Delta UR(t-3)$	(0.392) 0.108	[0.632] 0.142	(0.121) -0.231	[0.393] -0.980	(0.075) 0.094	[0.209] 0.645	(0.454) 0.400	[0.757] 0.453
$\Delta rwage(t-3)$	(0.762) -0.055	[0.887] -0.461	(0.235) 0.087	[0.327] 2.383	(0.146) -0.047	[0.519] -2.069	(0.882) -0.156	[0.650] -1.133
$Dimpulse$	(0.119) -0.163	[0.645] -9.576	(0.037) 0.001	[0.017] 0.132	(0.023) 0.002	[0.039] 0.699	(0.137) -0.249	[0.257] -12.633
$2008Q4$	(0.017) -0.055	[0.000] -3.198	(0.005) 0.000	[0.895] 0.059	(0.003) 0.004	[0.485] 1.135	(0.020) -0.103	[0.000] -5.130
$2014Q1$	(0.017) 0.001	[0.001] 0.302	(0.005) 0.002	[0.953] 2.318	(0.003) 0.000	[0.256] -0.437	(0.020) 0.007	[0.000] 2.243
$Const$	(0.003) 0.003	[0.762] 0.003	(0.001) 0.001	[0.020] 0.001	(0.001) 0.001	[0.662] 0.001	(0.003) 0.003	[0.025] 0.025
ARCH-LM Test	χ^2 – statistic 13.5444	p-value 0.6326	χ^2 – statistic 11.1602	p-value 0.7995	χ^2 – statistic 16.9358	p-value 0.3898	χ^2 – statistic 10.0497	p-value 0.8640
Normality Test	JB-statistic 1.7287	p-value 0.4213	JB-statistic 1.2828	p-value 0.5265	JB-statistic 2.9225	p-value 0.2319	JB-statistic 0.2512	p-value 0.8820

Source: evaluation of the authors.

Table 4. Cointegration vector and loading parameters

	<i>rgdp – empl</i>	<i>empl</i>	<i>UR</i>	<i>rwage</i>	<i>Trend</i>	<i>Dshift2008Q4</i>
β	1.00	-11.68 (1.73) [-6.77] {0.00}	-3.113 (2.66) [-1.17] {0.24}	0.672 (0.24) [2.84] {0.005}	-0.01 (0.002) [-3.82] {0.00}	0.232 (0.06) [4.21] {0.00}
α	-0.251 (0.06) [-4.26] {0.00}	0.127 (0.02) [7.00] {0.00}	-0.021 (0.01) [-1.88] {0.06}	-0.163 (0.07) [-2.39] {0.02}		

Note: standard errors in parentheses (); t-statistics in [], p-value in {}.

Source: evaluation of the authors.

If we normalize cointegration vector, with estimation of coefficients presented in Table 4 so that the coefficient by real wage is equal to unity, then the received cointegration relation can be considered as a stationary equilibrium long-term relationship between real wages, productivity and unemployment. Rewriting it in the form of wage setting relation (7), we obtain

$$rwage_t = -1,488 (rgdp - empl)_t + 17.38 empl_t + 4.637 UR_t + 0.010 Trend - 0.345 Dshift2008Q4 + e_t. \quad (11)$$

Should be noted that in equation (11) the coefficient of labor productivity is negative, but its sign may be just a consequence of including of a linear trend variable in cointegration relation. In this equation trend, in particular, may be interpreted as a proxy for productivity and factor of productivity growth. However, as the modeling show, given the relatively small coefficient under variable *Trend*, productivity growth in Ukraine does not cause a corresponding increase in real wages and the relationship between these factors is not clear. The rest of estimated coefficients are consistent with theoretical considerations. Growing number of employees is accompanied by an increase in wages, which indicates it's pro-cyclical. In addition, real wages have inverse relation to the level of unemployment. However, the corresponding coefficient by *UR_t* variable is not significant at conventional levels. Therefore, we receive that the unemployment rate does not affect the process of wage setting in Ukraine that, in particular, indicates the existence of weak institutions of labor collectives and trade unions, and that insiders and outsiders of labor market have no influence on this process.

Developed SVEC model allows to analysing the dynamic effects of structural shocks influence on output level and unemployment. Impulse analysis of VEC model

$$\Delta y_t = \alpha \beta' y_{t-1} + \Gamma_1 \Delta y_{t-1} + \dots + \Gamma_p \Delta y_{t-p+1} + u_t \quad (12)$$

is carried out on the basis of moving average representation (Lutkepohl, Breitung and Bruggemann, 2004, p. 168)

$$\Delta y_t = \Psi u_t + \sum_{i=1}^t \Phi(L) u_i + y_0, \quad (13)$$

where Ψ – is a long-run impact matrix, and $\Phi(L)$ – is an infinite-order polynomial in the lag operator with coefficient matrices Φ_j , that go to zero as $j \rightarrow \infty$ and contain transitory effects. The term y_0 contains all initial values.

In the model (1) – (8) vector of structural shocks is given $\varepsilon_t = (\varepsilon_t^{technology}, \varepsilon_t^{demand}, \varepsilon_t^{supply}, \varepsilon_t^{rwage})'$. Since they are not directly observed, the identification of their impact requires some assumptions. In a number of studies different schemes of labor market model identification were proposed. In particular, the Bean (1992) proposed to base modeling subject to constant returns to scale ($\rho = 1$), it means that in the long-term period productivity is determined only by technological trend. Another possible restriction $\lambda = \eta = \delta = 1$ corresponds to the Layard-Nickell condition (Layard and Nickell, 1986) and means that in the long term unemployment rate does not depend on technology trend or labor supply trend. Jacobson et al. (1998) used the assumption $\lambda\rho = 1$, which also defines different situations depending on the number of available common trends. In the case of two trends a restriction means that the long-term dynamics of real wages is caused only by technological trend. In the case of three trends, a restriction describes a situation in which real wages and labor force does not depend on the trend of equilibrium unemployment.

To identify shocks in the model of Ukrainian labor market we will use restrictions on the long-run impact matrix according to the ideas of Blanchard and Quah (1989). As the estimated cointegration relation is consistent with the wage-setting relation, its stationary detects that wage shocks have no long-term impact on the variables included in y_t . Such conclusions correspond to zero last column of long-run effects matrix $\Omega = \Psi B$. Also assume a constant effect of scale and that supply shocks have no long-run impact on real wages.

Having added imposed restrictions and estimated long-run impact matrix, we obtain

$$\hat{\Omega} = \begin{pmatrix} 0.0140 & 0 & 0 & 0 \\ [4.24] & & & \\ 0.0025 & 0.0014 & -0.0004 & 0 \\ [3.39] & [1.51] & [-2.81] & \\ -0.0014 & -0.0015 & 0.0015 & 0 \\ [-2.05] & [-1.42] & [2.92] & \\ 0.0164 & 0.0177 & 0 & 0 \\ [2.56] & [1.48] & & \end{pmatrix}.$$

In parentheses we provide bootstrapped t-values obtained using 200 bootstrap replications.

Using the obtained estimations we calculate impulse response functions for labor market indicators to structural shocks that provide more informative picture of dynamic effects of macroeconomic shocks on the domestic labor market. Graphic representation for impulse response functions values of developed SVEC model together with 95% and 90% confidence intervals are shown in Fig. 3–5. Confidence intervals are determined on the basis of Hall's bootstrap percentile intervals (Lutkepohl, Breitung and Bruggemann, 2004, p. 177).

Results of modeling show that the technological shock has a significant long-term dynamic influence for all variables. Variables of productivity, employment and real wages react to shock contemporaneously, only unemployment rate shows delay in one period. Should be noted that a short-term adaptation to new long-run equilibrium levels is enough fast for all indicators. Within four quarters all variables reach a new level, and then within one year show some fluctuation, and after 8 quarters they are fully stabilized at a new equilibrium level.

The positive labor supply shock immediately leads to higher unemployment, which is two quarters is slightly reduced, but after a year it is stabilized at a new long-term level which is exceeding the initial. We also note that the number of employees on contrary slowly adapt to his new equilibrium level. Calculated confidence intervals detect that the response of employment to supply shock is not contemporaneous and significant negative changes in the number of employees caused by a positive labor supply shock will be seen only after approximately 2.5 years.

In general impulse response characteristics correspond to what would be expected according to economic theory. Also, we should note that adaptation to a new equilibrium of labor market takes about two years regardless of the reasons labor market disturbances.

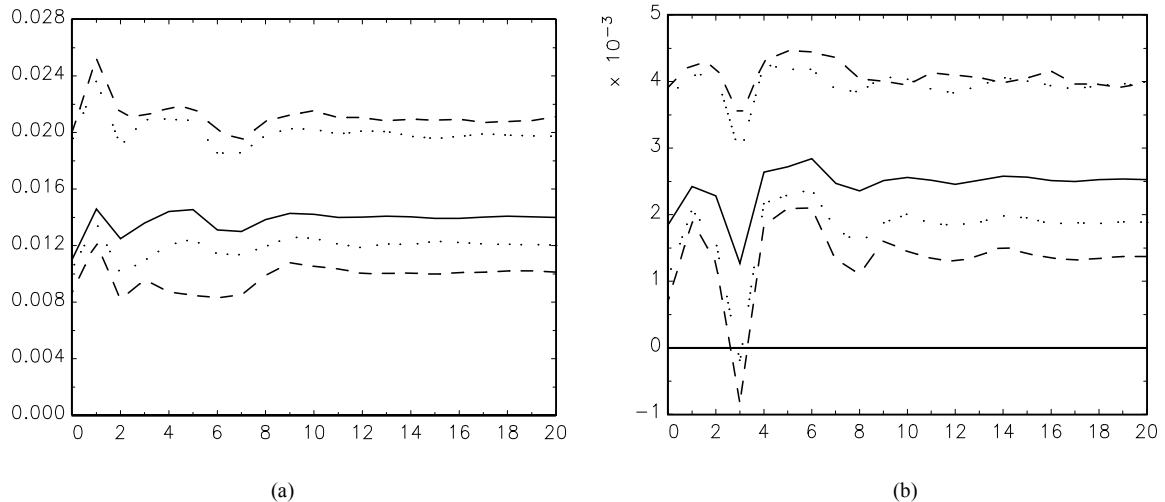


Fig. 3. Impulse response functions to technological shock for (a) productivity; (b) employment.
Source: evaluation of the authors.

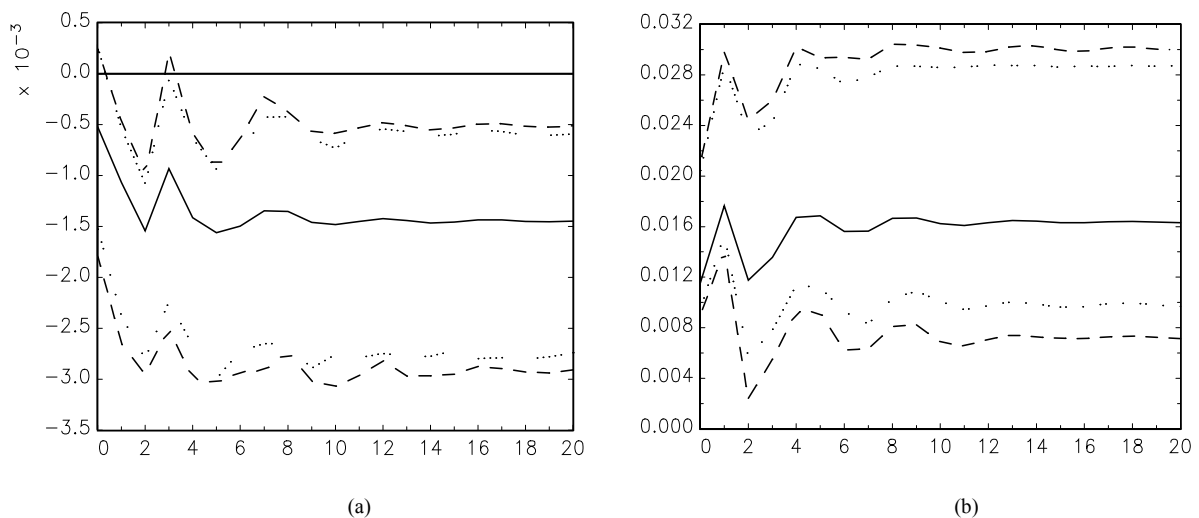


Fig. 4. Impulse response functions to technological shock for (a) unemployment rate; (b) real wages.
Source: evaluation of the authors.

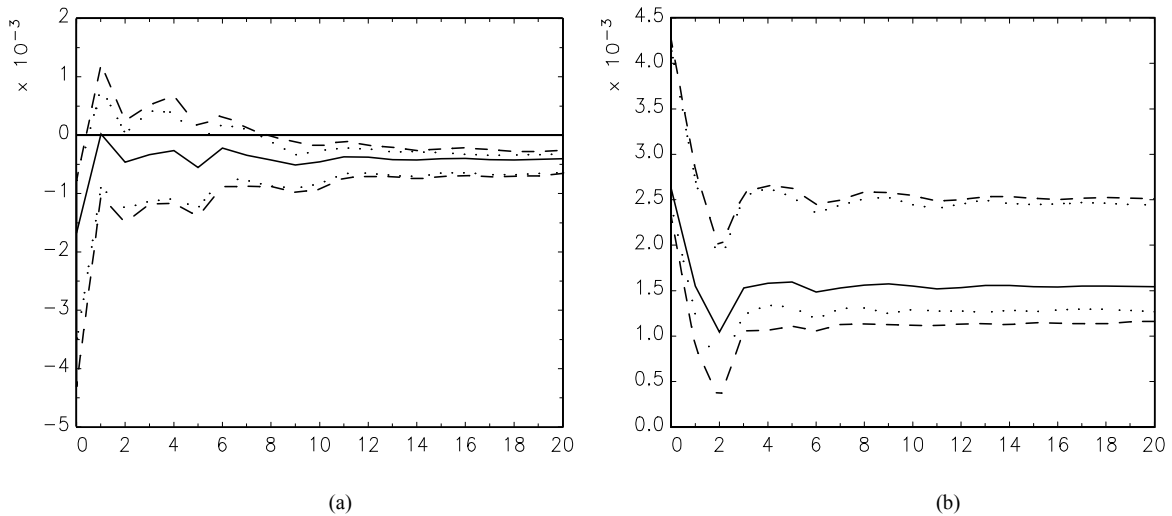


Fig. 5. Impulse response functions to labor supply shock of (a) employment; (b) unemployment rate.
Source: evaluation of the authors.

To assess the relative importance of the identified labor market shocks, we also calculate the forecast error variance decomposition for different horizons h (Table 5). Results of the study show that labor supply shocks are the main source of Ukrainian unemployment in the short-term, while over time the proportions of technological shocks and demand shocks are growing and in the long-run about 60% of the variations in the variables of unemployment can be attributed to demand shocks and technologies shocks.

Variations in the levels of wage are mainly caused by technological shocks and demand shocks, and their shares are almost the same and do not change with time. Modeling shows that these shocks play an equally important role in explaining fluctuations of real wages in the short and in the long run.

Table 5. Forecast error variance decomposition of Ukrainian unemployment and real wages

Forecast horizon	Unemployment				Real wage			
	$\epsilon_t^{technology}$	ϵ_t^{demand}	ϵ_t^{supply}	ϵ_t^{rwage}	$\epsilon_t^{technology}$	ϵ_t^{demand}	ϵ_t^{supply}	ϵ_t^{rwage}
1	0.03	0.05	0.87	0.05	0.46	0.47	0.00	0.07
2	0.10	0.15	0.68	0.07	0.55	0.42	0.00	0.03
3	0.21	0.15	0.57	0.07	0.45	0.53	0.00	0.02
4	0.19	0.24	0.52	0.05	0.43	0.55	0.00	0.02
5	0.22	0.24	0.49	0.05	0.45	0.54	0.00	0.01
6	0.25	0.23	0.48	0.04	0.46	0.53	0.00	0.01
7	0.26	0.24	0.46	0.04	0.46	0.53	0.00	0.01
8	0.26	0.27	0.44	0.03	0.45	0.54	0.00	0.01
12	0.28	0.29	0.41	0.02	0.45	0.54	0.00	0.01
16	0.29	0.30	0.40	0.01	0.46	0.54	0.00	0.00
20	0.29	0.31	0.39	0.01	0.46	0.54	0.00	0.00
30	0.30	0.31	0.38	0.01	0.46	0.54	0.00	0.00
40	0.30	0.32	0.37	0.01	0.46	0.54	0.00	0.00

Source: evaluation of the authors.

Decomposition of variance in the number of employees shows that if in the short term the determining factors of changes in employment are wage-setting shocks, then in the long run approximately 70% of variations are explained by technological shocks and 24% by labor demand shocks. Technological shocks explain 97% of labor productivity variation in the long run. Although during the first two quarters the labor demand shocks and wage shocks determine only 15-20% of variance in productivity fluctuations.

5. Conclusions

The effectiveness of mechanisms of social and economic regulation in Ukraine requires deepening the analysis and modeling of processes on the labor market that will allow to take into account the effects of different types of shocks that are specific to the unstable economic development of our country, and to evaluate their impact both in the short and in the long run. In the result of conducted empirical analysis we created structural vector autoregressive error correction model for labor productivity, employment, unemployment rate and real wages. The analysis of impulse response to technological shocks, labor demand shocks, labor supply shocks and wage shocks was conducted on the basis of developed SVEC. The modeling results demonstrated that in Ukraine there is no single reason for hysteresis in unemployment. Various structural and cyclical shocks explain unemployment over different time horizons. In particular, labor supply shocks lead to contemporaneous growth of unemployment, while in the long run positive technological shocks and labor demand shocks are an important source of reducing unemployment rate. Technological shocks also have a significant beneficial impact on other labor market indicators. In particular was found that a positive technological shock causes an increase in productivity, employment and real wages, and this impact has a significant effect both in the short and in the long run. In addition we can see that in temporary labor demand shocks have a permanent effect on the labor market which shows a high degree of the national economy inertia.

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